

# Monitoring of FHEP

Teacher Research Internship  
Fermilab – Summer 2011

# Summer Internship

## My nine week internship:

- Labview program for FHEP stress monitoring
- Hardware testing for stress gauge monitoring
- Installation of strain gauges on FHEP
- Ultrasonic gage projects

# NOvA Neutrino Experiment

- The NOvA neutrino experiment will start studying the properties of neutrinos starting 2013.
- Construction is scheduled to be complete in January 2014, and the first run will last six years.

# NOvA Neutrino Experiment








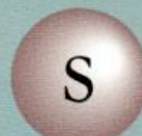




## ■ Background

- There are three types of neutrinos: muon, electron and tau neutrinos
- Scientist have observed muon neutrinos oscillate into tau neutrinos.
- However, scientist have not observed muon neutrinos oscillating into electron neutrinos.



# NOvA Neutrino Experiment

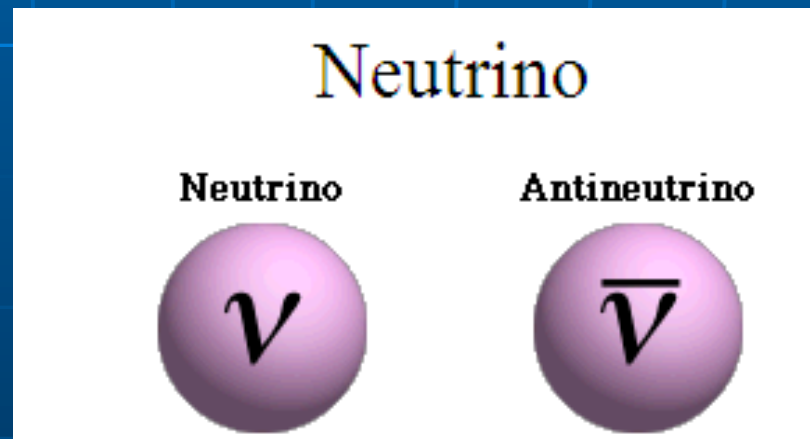
- Goals of the experiment:
  - Observe the oscillation of muon neutrinos to electron neutrinos

	LEPTONS		QUARKS	
<b>FIRST FAMILY</b>  "Ordinary" matter, least massive	 electron	 electron neutrino	 up	 down
<b>SECOND FAMILY</b>  Similar properties, more massive	 muon	 muon neutrino	 charm	 strange
<b>THIRD FAMILY</b>  Rarest particles, most massive	 tau	 tau neutrino	 top	 bottom

Source: Lawrence Berkeley National Laboratory

# NOvA Neutrino Experiment

- Discover the order of neutrino masses: Which one is the heaviest? Which is the lightest?
- Discover the symmetry between matter and antimatter



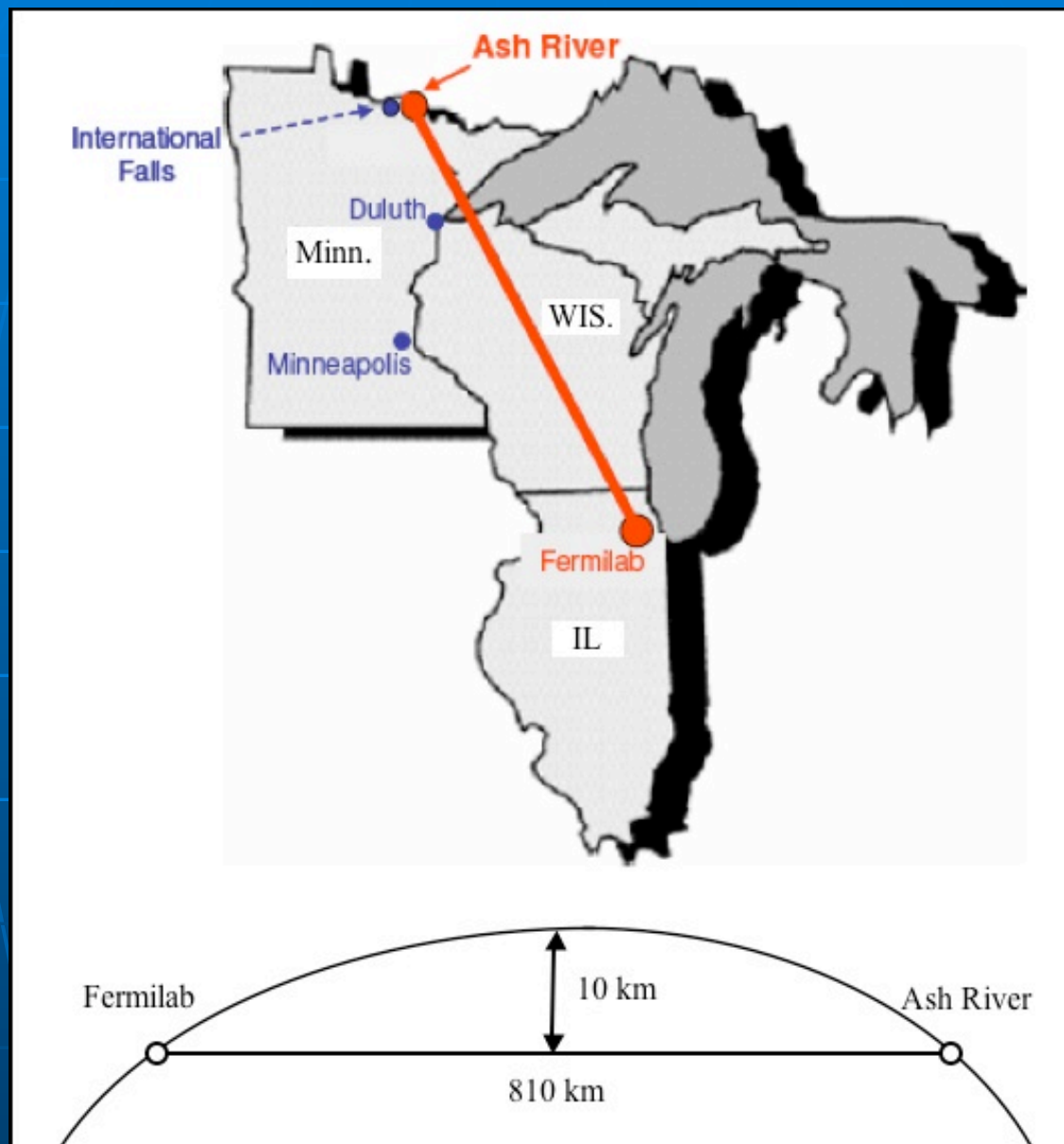
Source: Jefferson Lab's web server

# NOvA Neutrino Experiment

- Neutrinos normally do not interact with other particles
- A beam of neutrinos will be generated from the NuMI neutrino beam
- The neutrinos will travel straight through the Earth since they rarely interact with other particles.
- Scientists will use statistics to determine if the muon neutrinos are oscillating into electron neutrinos.

# NOvA Neutrino Experiment

- The near detector should detect mostly muon neutrinos and only a few electron neutrinos.
- If the far detector detects more electron neutrinos, then it can be concluded that some of the muon neutrinos have become electron neutrinos during the 500 mile trip to Minnesota. (The neutrinos make this trip in 3 milliseconds).

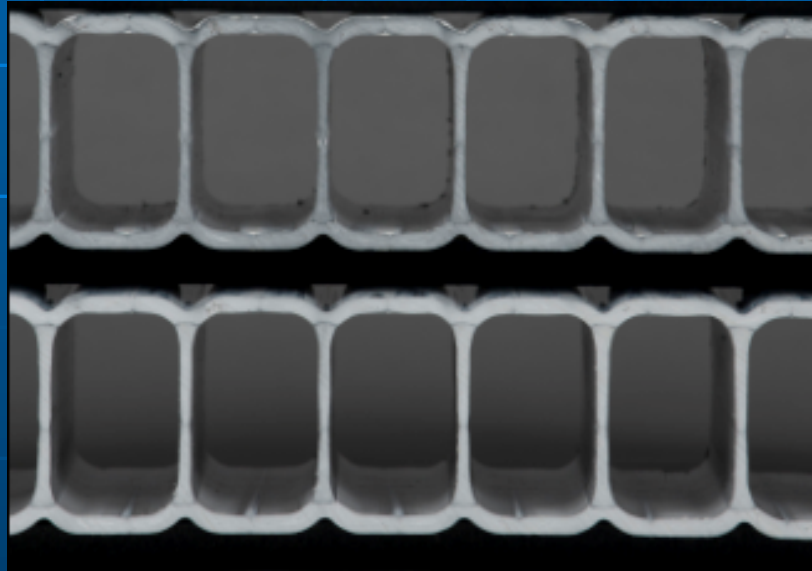


Source: NOvA documents



# NOvA Neutrino Experiment

- The detectors are constructed of highly reflective PVC cells filled with liquid scintillator.



Source: NOvA documents

# NOvA Neutrino Experiment

- The charged particles produced by the neutrino interaction inside the detector will cause the liquid scintillator to produce light that is captured by optical fibers and carried to light-sensitive detectors.

# NOvA Neutrino Experiment

- The near detector: 200 ton detector in the NuMI Service Building

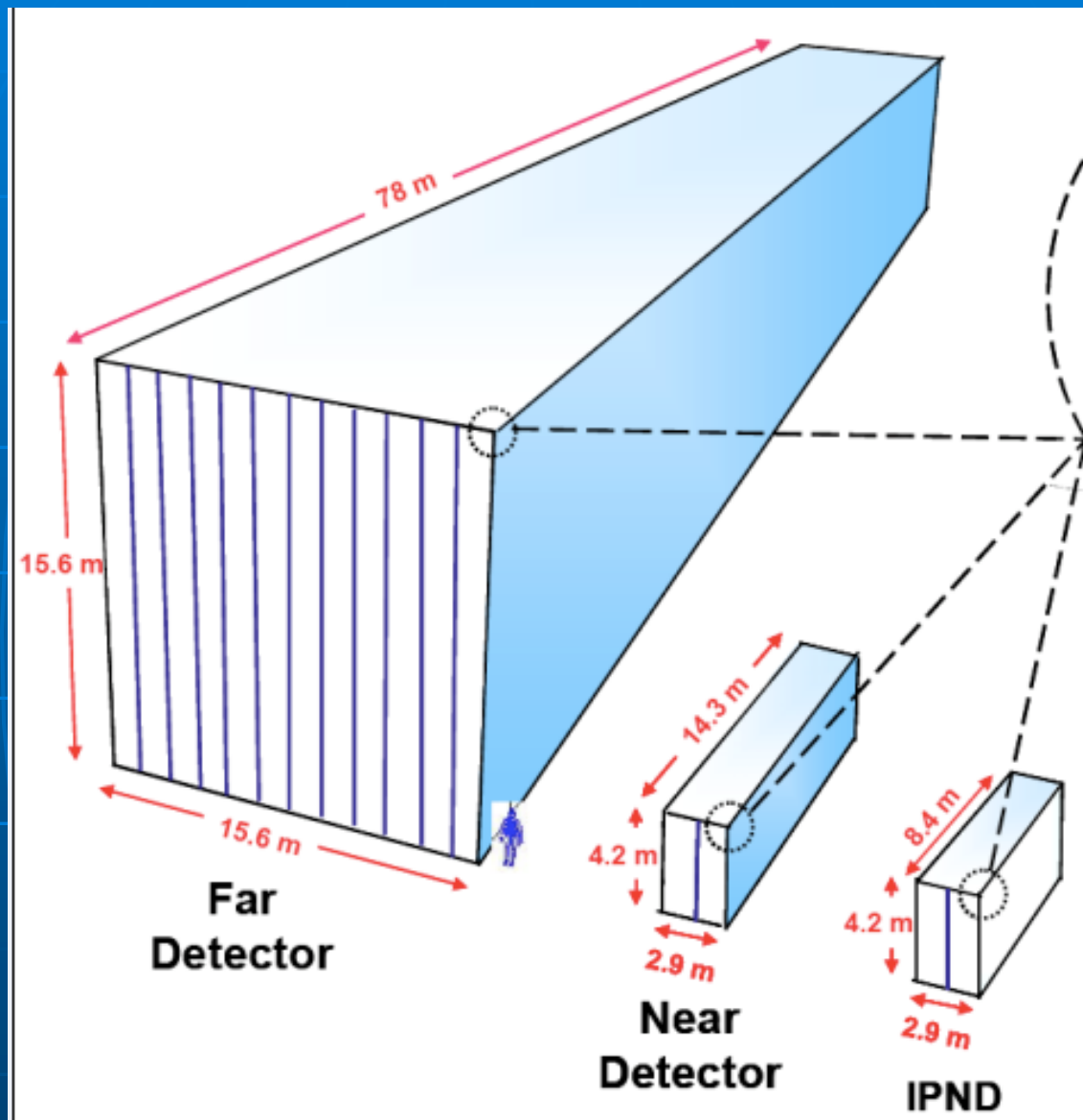




# NOvA Neutrino Experiment

- The far detector is 15,000 ton will e located in Ash River, Minnesota.





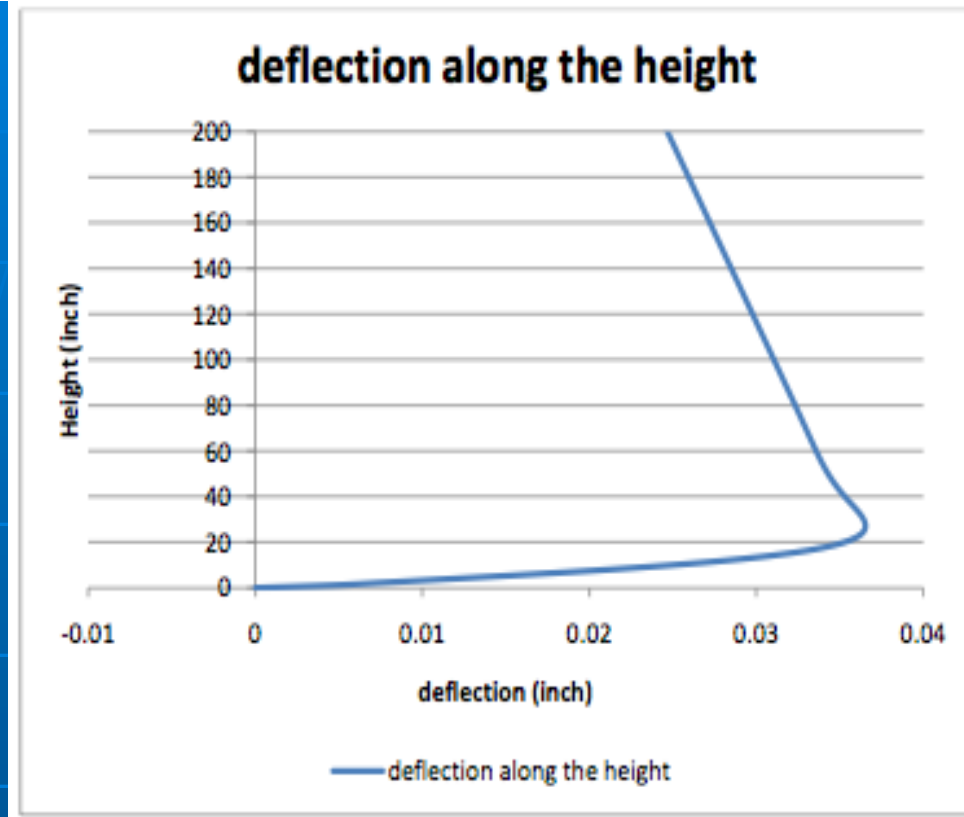
Source: NOvA documents

# NOvA Neutrino Experiment

- FHEP, Full Height Engineering Prototype of the far detector. Will be located in the CDF building in in August 2011.

# FHEP Stress Monitoring

- The liquid scintillator will cause the PVC cells to stretch especially near the bottom of the detector.
- Stress will linearly increase from the top of the block to the bottom of the detector.
- Most of the stress is in the range of 300 psi with height below 100" with the largest amount of stress at approximately 30 ".



Source: Ting Miao

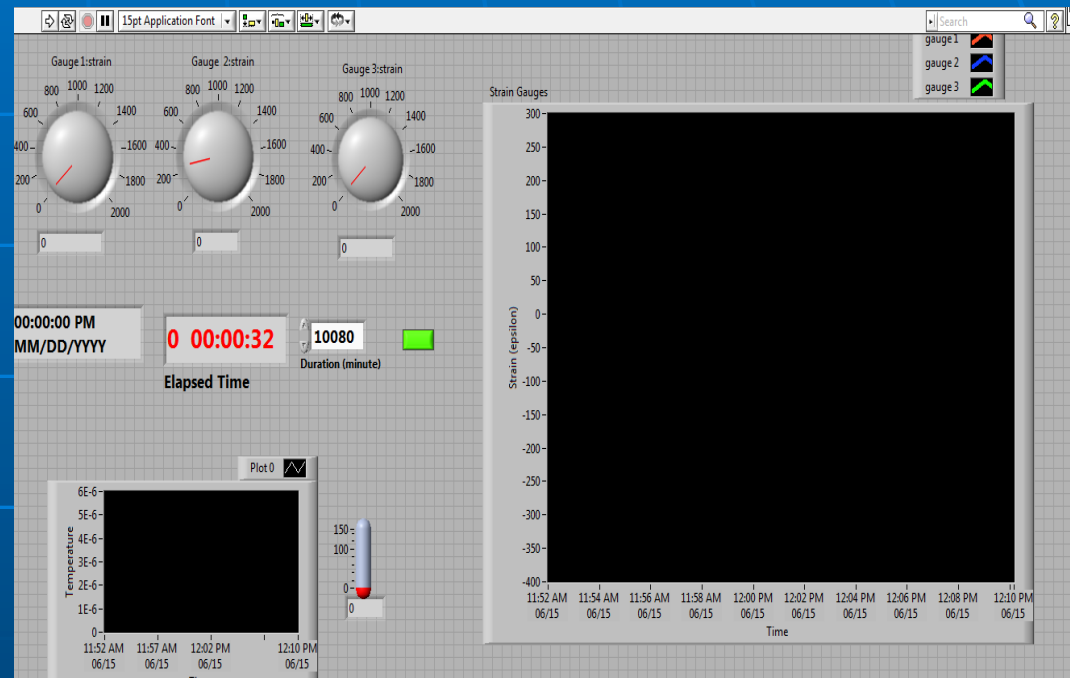
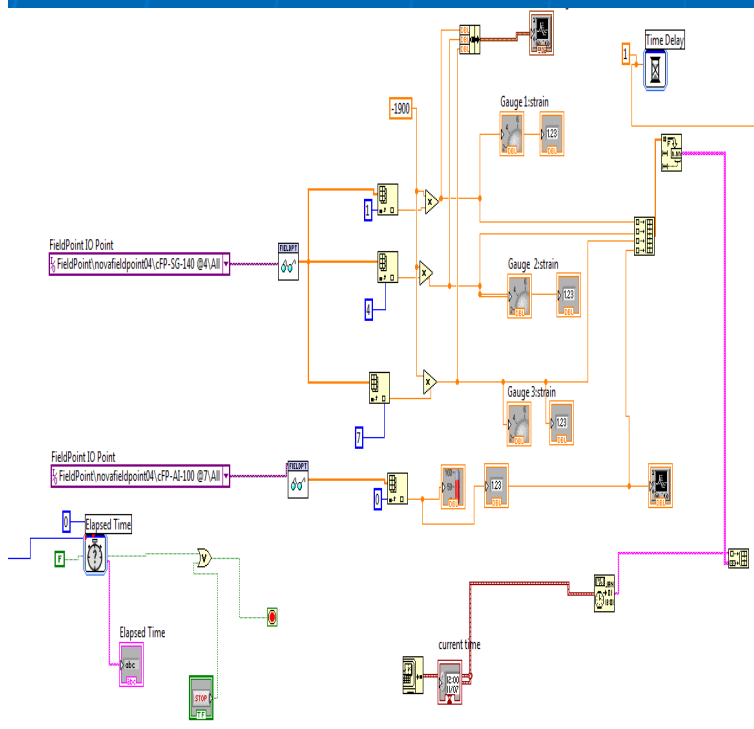
- strain range is about 1000 micro-strain (at  $E=0.3\text{mpsi}$ , 6month) and will increase to 4000 micron-strain at 20 years ( $E=0.07\text{mpsi}$ , 20year)

# Labview Program for FHEP Stress Monitoring

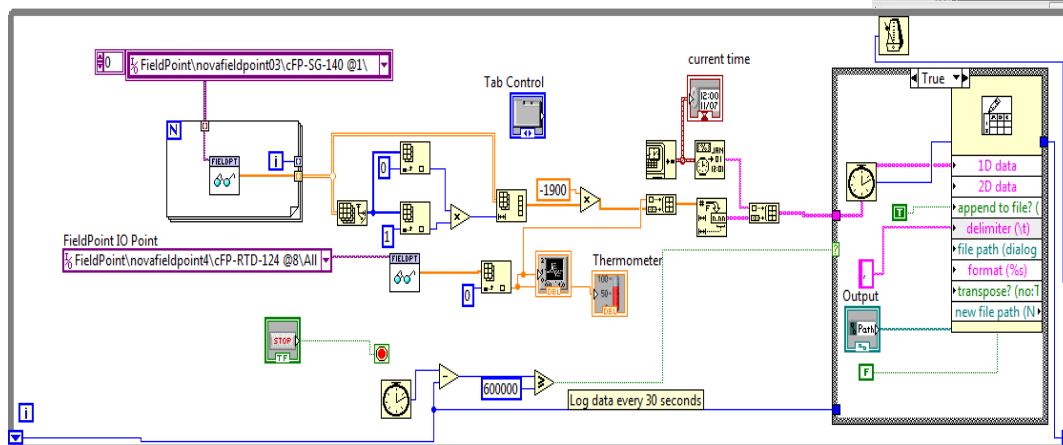
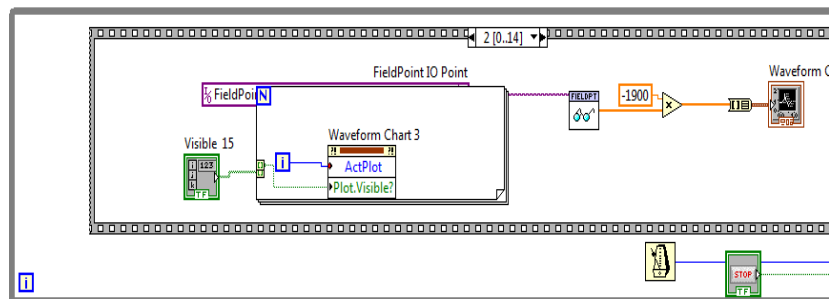
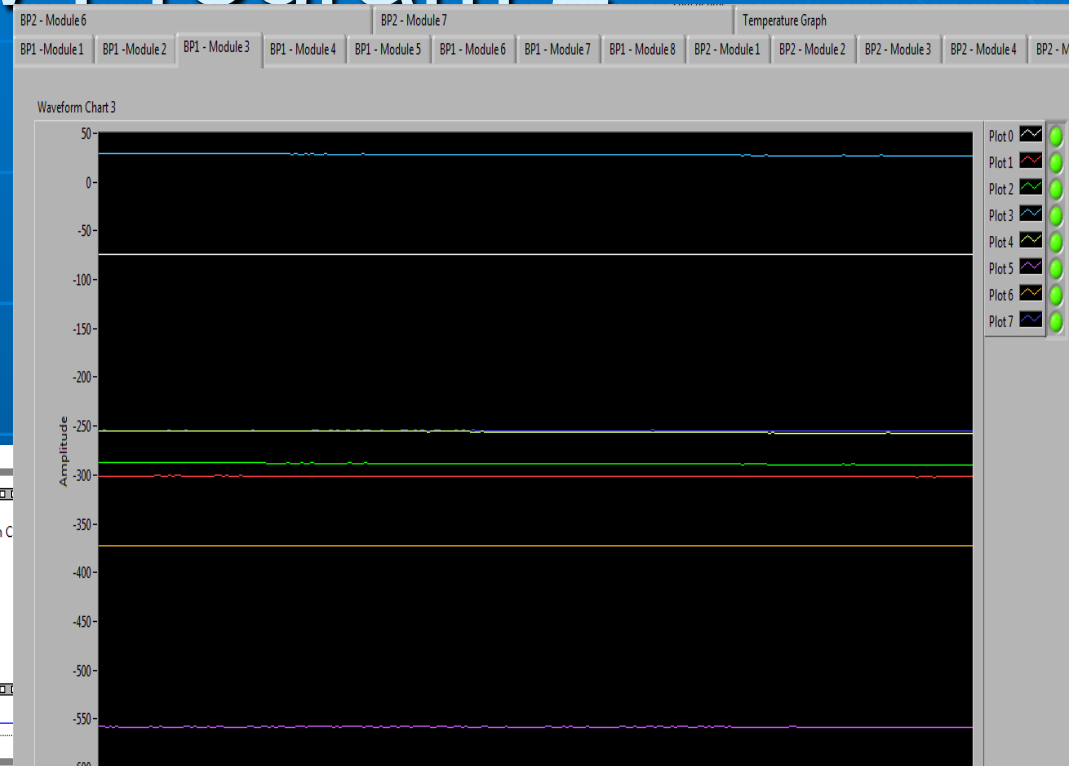
- Used previous Labview knowledge, National Instruments discussion forums, Trial and Error, and Geoffrey Schmit
- An ongoing process.....



# Labview Program 1



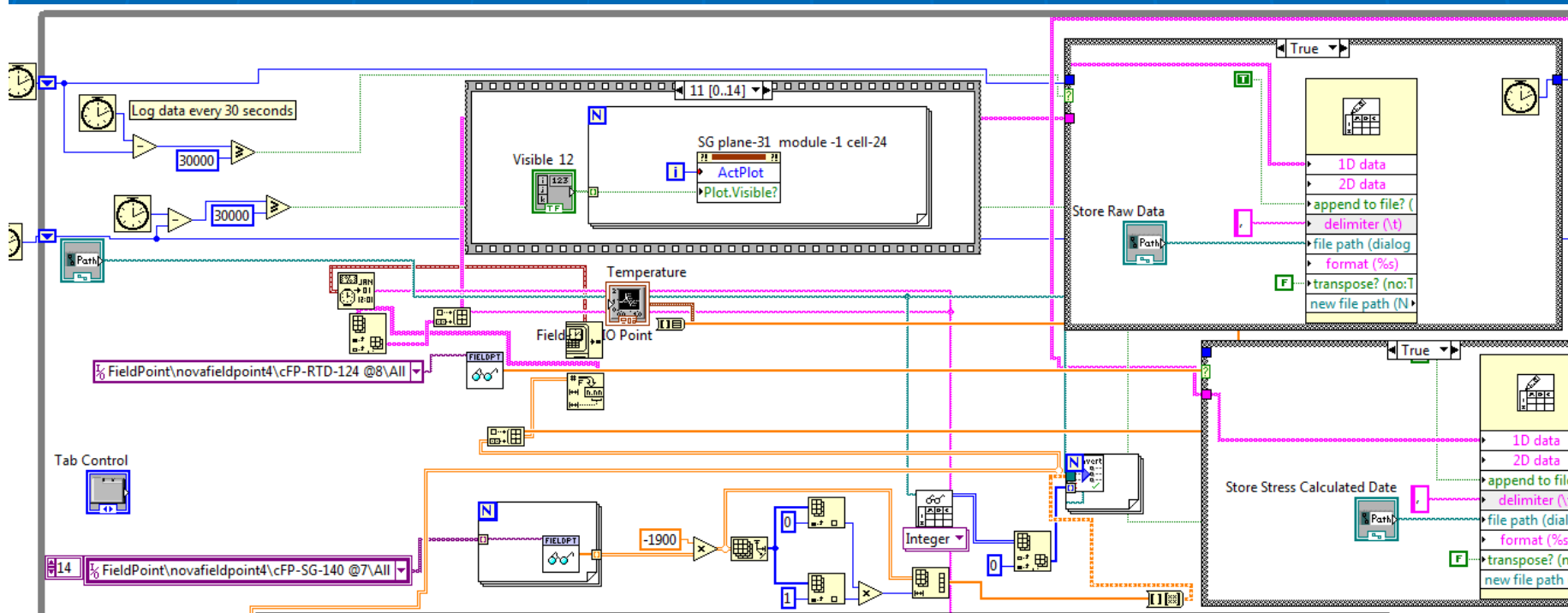
# Labview Program 2



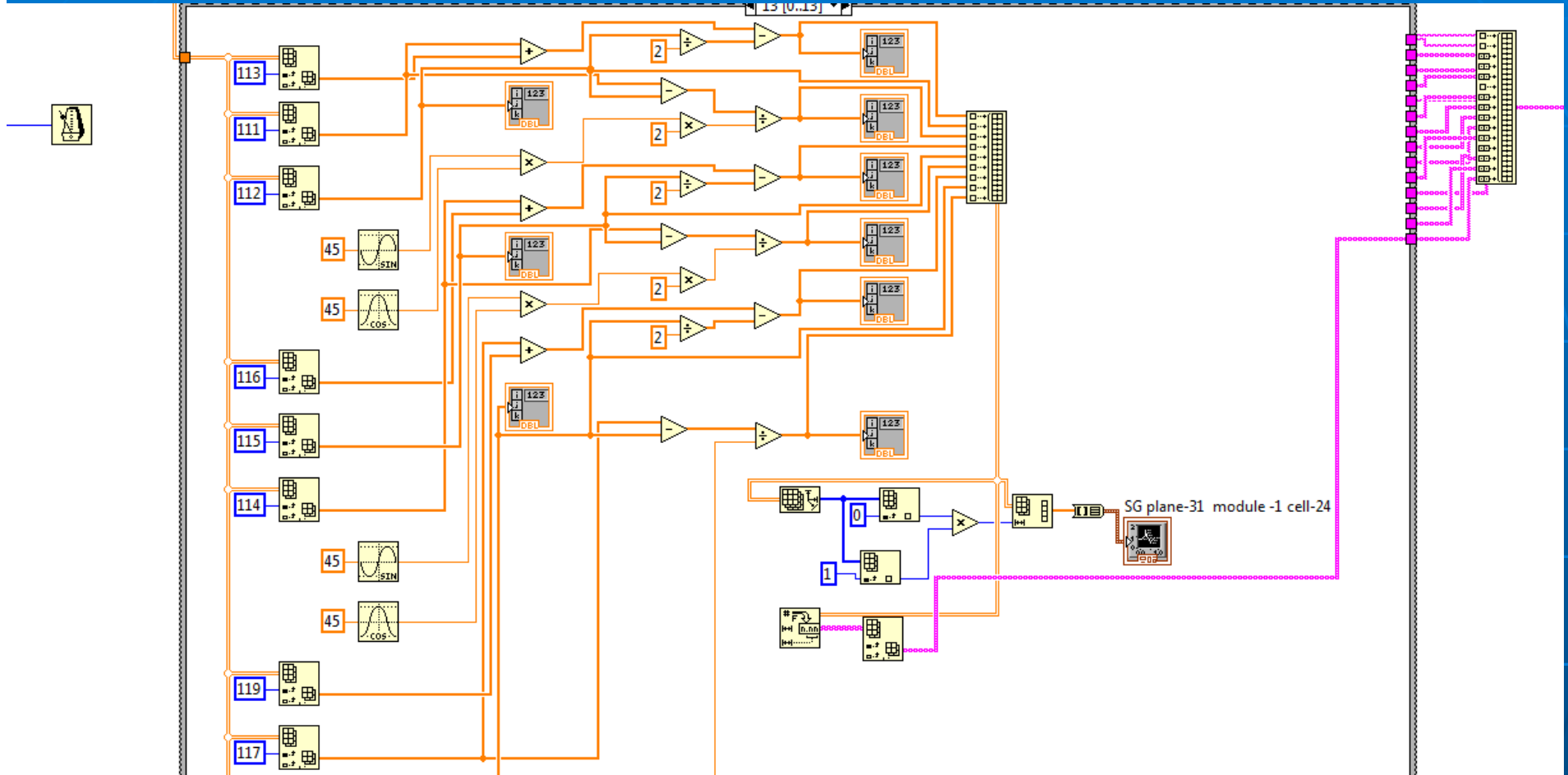


# Labview Program 3

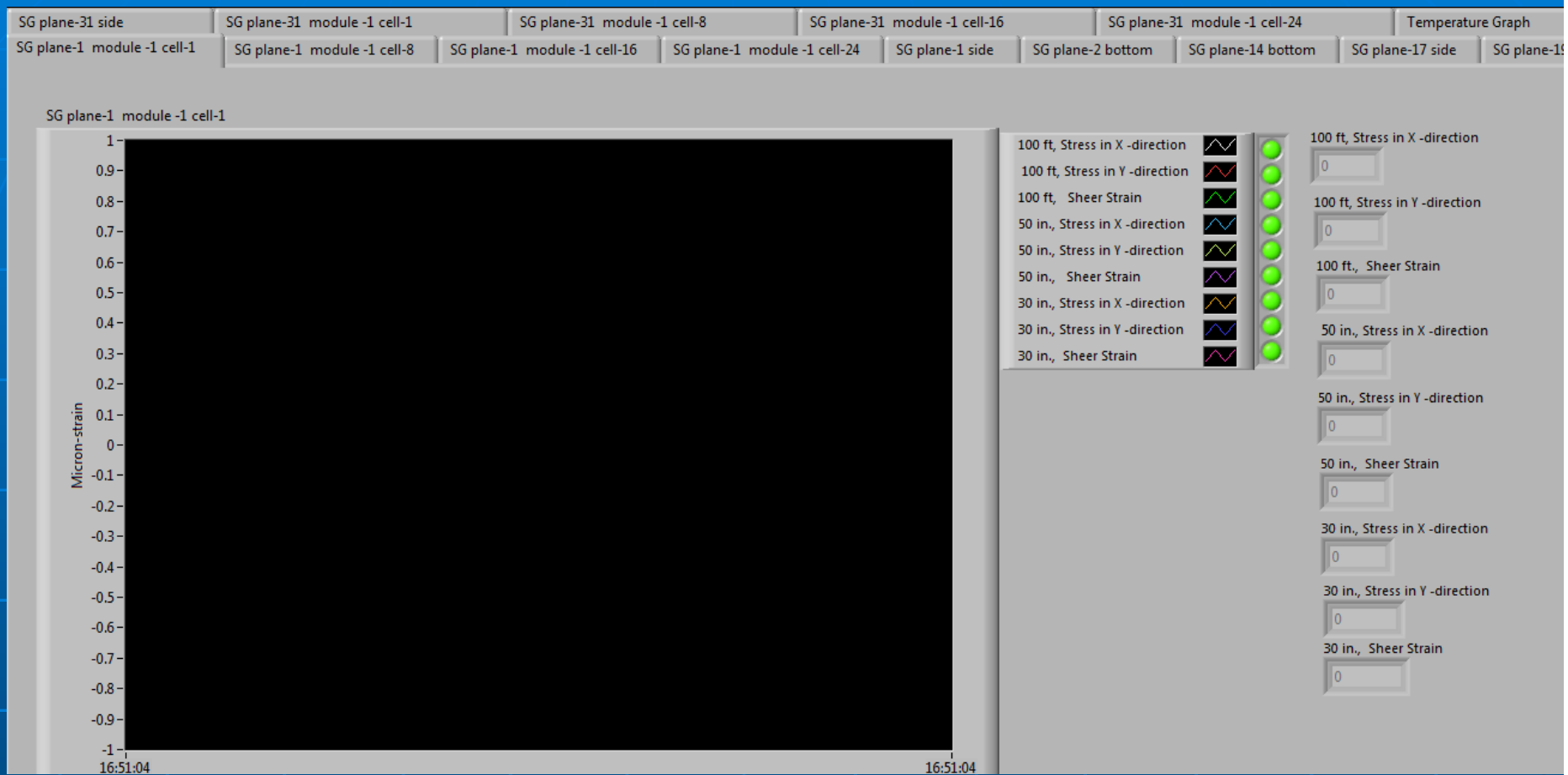
After numerous changes – the current program not yet complete



Top half of the program



Bottom portion of program for strain gauge graphs and indicators



Front panel of program

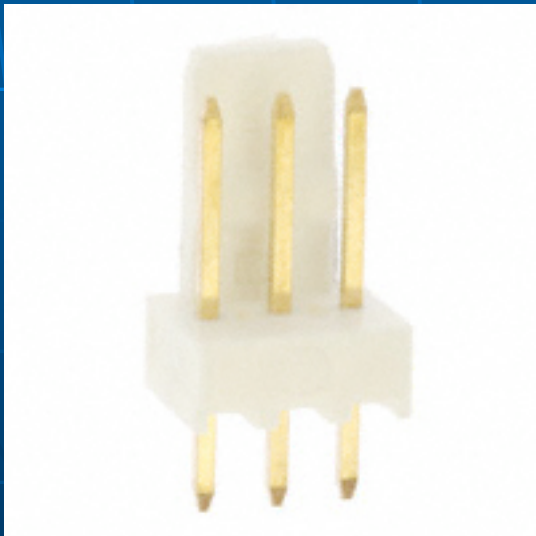
# Hardware Testing for Stress Gauge Monitoring

- 15 National Instruments SG-140 Strain Gauge module
  - 114 channels
- 1 National Instrument RTD-124 Temperature module
  - 8 channels



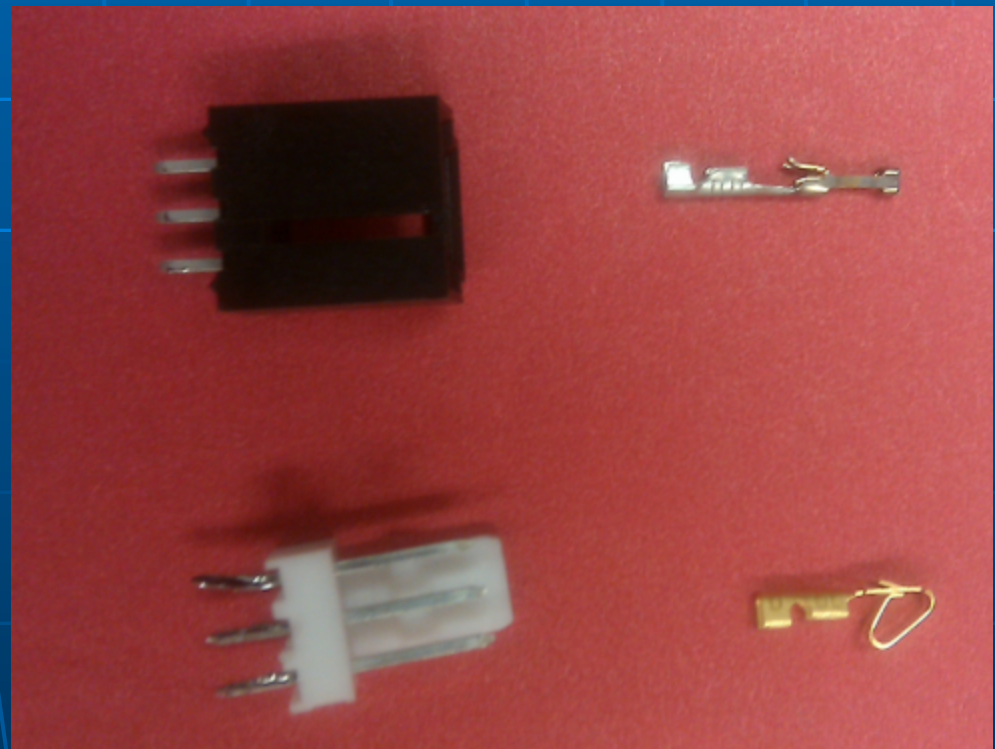
# Hardware Testing for Stress Gauge Monitoring

- Unstable connections of module to strain gauge

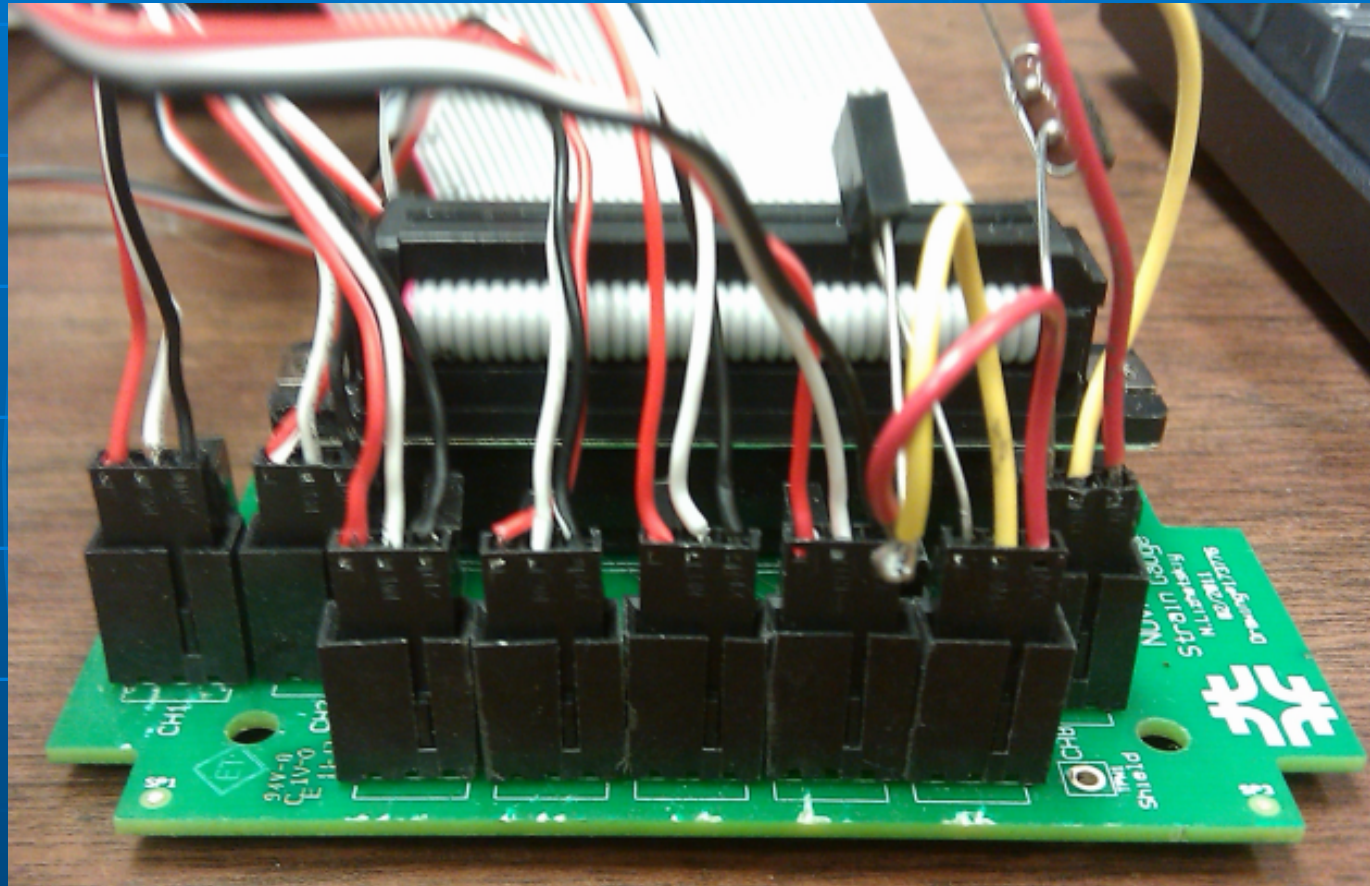


# Hardware Testing for Stress Gauge Monitoring

- Solutions – Use of gold connectors with pin and socket connectors

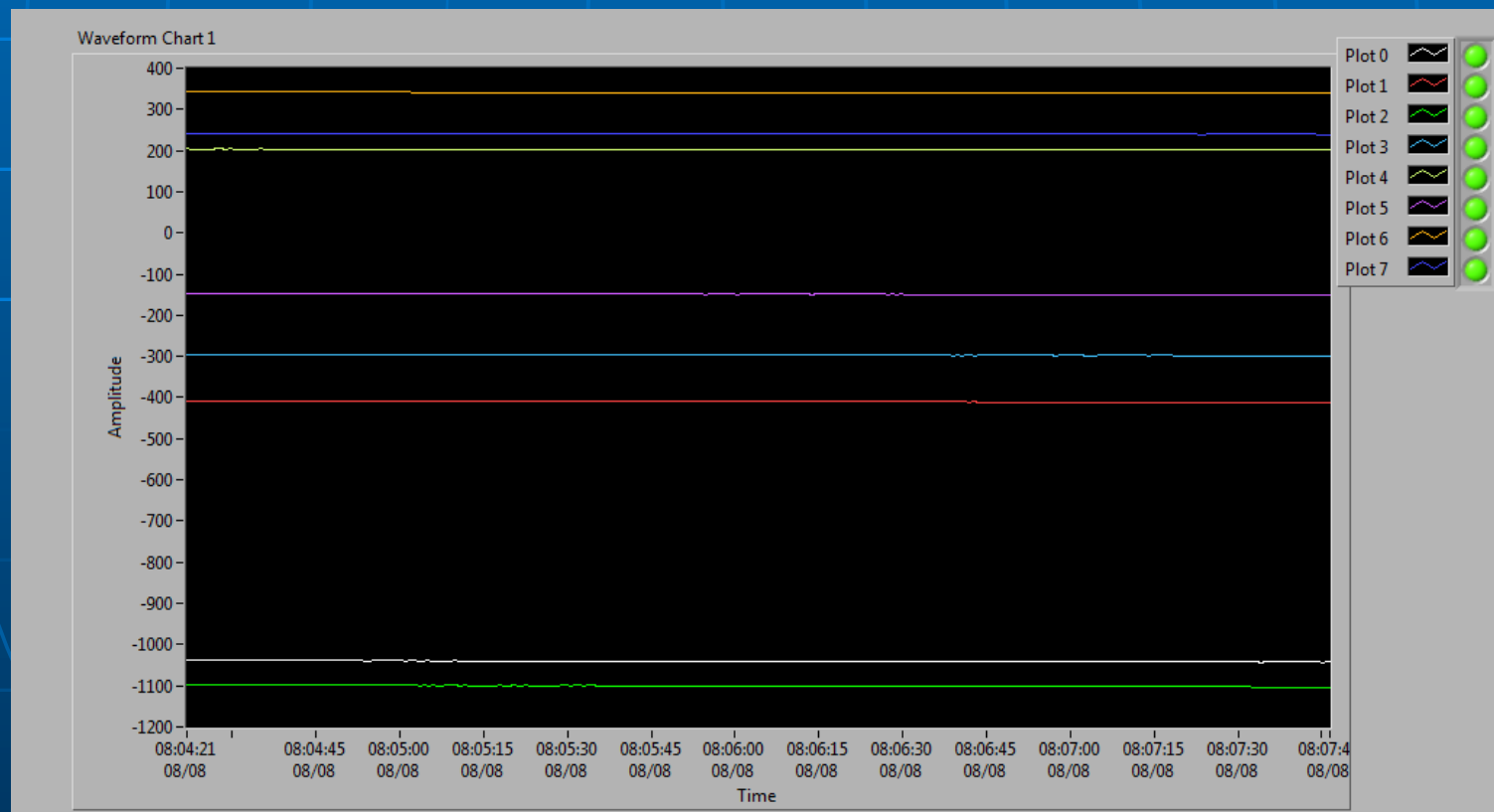






# Hardware Testing for Stress Gauge Monitoring

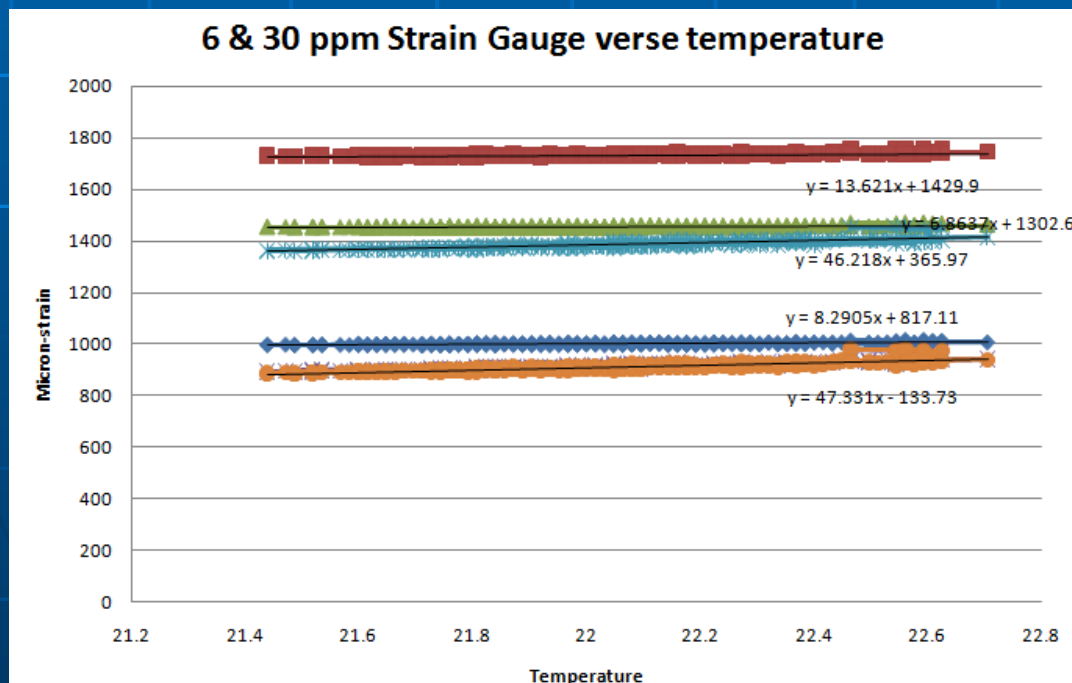
- Problem – 114 channels with different at rest (no stress) readings





# Hardware Testing for Stress Gauge Monitoring

- Solution:
  - Null Correction after numerous test and contacting NI support



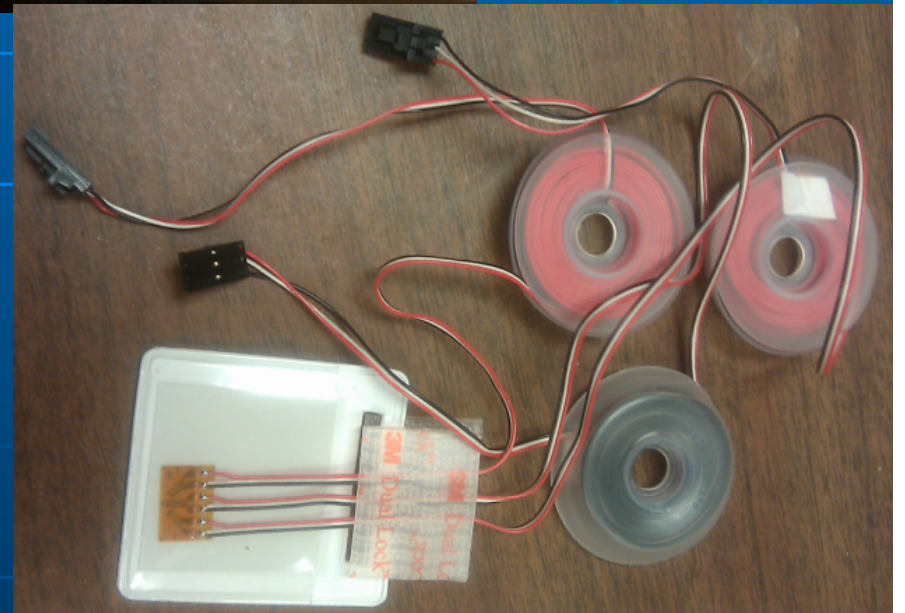
Different for each channel  
(120 channels) and  
temperature dependent

$$Y = k\Delta T + b$$

Slope depended on type of strain  
gauge and temperature

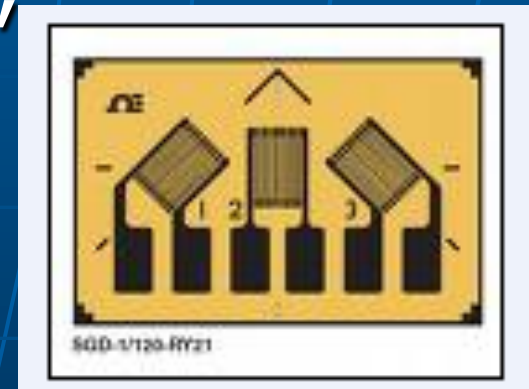






# Installation of strain gauges on FHEP

- Researched epoxy and coating to protect strain gauges
  - M Bond AE-10
- Researched coating for Stress gauges to protect them from chemicals, environmental, and mechanical issues





# What I will take back to the classroom

1. The standard model of the atom
2. The opportunities the students have in the science world and for local internships
3. The process of science –
  - a. More inquiry labs
  - b. More open ended problem solving

# Thank You

Mentor: Ting Miao

Guest Scientist: Nickolay Luzhetskiy

TRAC Program Coordinators:  
Harry Cheung & Bjoern Penning